# Space Weather Technical Forecast

Issued on Monday, 13 May 2024 at 13:29 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

*Please note: On the 14 May between 1500 UTC and 2100 UTC, a significant data outage at NOAA SWPC is expected which will impact most of our observational data feeds and some models. We may receive data intermittently through that period. MOSWOC service will continue on contingency. Alerts and warnings will be sent using alternative data, if available. The planned data outage may be postponed in the event of significant space weather.*

**Space Weather Forecast Headline: G1-G2 (Minor-Moderate) Geomagnetic storms possible day 1 (13 May), but risk then easing. Chance of X-class flares from AR3664 mainly days 1-2 (13-14 May) before easing.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** High with an X1.0 flare observed 12/1626 UTC from AR3664, along with numerous M-flares. The most notable an M4.8 at 12/2030 UTC and a long period M6.6 at 13/0944 UTC. There are fourteen sunspot regions on the disc, with AR3664 remaining the most notable. This has continued to show development within its magnetic looping on SDO imagery, but is now approaching on the southwest limb and subsequently hard to assess. Given the history, size and complexity of the spot, this is expected to dominate the solar activity on the disc even as it rotates over the limb, with all other region all smaller and generally simpler. The main exception is perhaps AR3664 in the south-centre which has a very small delta configuration.

Further faint CMEs have been produced by AR3664, along with a much more notable CME from the long period M6.6-flare but currently only visible on STEREO A. Given the location of the spot, this is unlikely to have a significant Earth-directed component, however further SOHO imagery is required to confirm this.

**Solar Wind / Geomagnetic Activity:** Ongoing enhancement from the recent CME arrivals continued during the last 24 hours. The passage of the shock component of the 11/0115 UTC X5.8 flare CME perhaps occurred with a brief spike in solar winds to be very strong at near 1000 km/s at 12/1451 UTC. Otherwise solar winds speeds gradually and erratically eased from just below 900 km/s to be elevated at 650 km/s. This shock passage may have been followed by a glancing influence of the bulk material component, shown with the density rise from background to be above average around 13/2200 UTC, however this is speculative. Total Interplanetary Magnetic Field (IMF), Bt, persisted at Weak to Moderate levels, varying between 5-10nT, with the north-south component, Bz, largely negative (southward) but also Weak to Moderate with minimum -8 nT. Brief positive spells occurred, becoming largely weakly positive from 13/0630 UTC. Geomagnetic activity was Unsettled to Active (Kp3-4) but G1-G2 Minor to Moderate storm for a spell (12/2100-0600 UTC).

**Energetic Particles / Solar Radiation:** High energy proton flux (greater than 10MeV) observed at GOES18 has continued to ease from just above the S1 Radiation Storm level at 10pfu, to around 1-2 pfu. A recent uptick has occurred however, due to the M6.6 flare at 13/0944 UTC. High energy electron flux (greater than 2MeV) observed at GOES16 was Background to Moderate, reaching 391 pfu at 13/1125 UTC. The associated 24-hour fluence was well below the Active threshold. Observed fluence at 13/0000 UTC was 4.52e6 integrated pfu.

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# Met Office Space Weather Technical Forecast

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Further isolated X-class flares are likely day 1-2 (13-14 May) from AR3664 on the southwest limb, along with occasional M-class flares being expected.

**Solar Wind / Geomagnetic Activity:** There are now no Earth-directed CMEs anticipated, however the M6.6 flare CME is yet to be assessed. Otherwise, ongoing CME enhanced solar winds, along with any slight influence from CH36/+ is expected to gradually ease. Activity is expected to be Unsettled to Active at first with an ongoing potential for further G1-G2 Minor-Moderate storms. However this risk declines through day 1-2 (13-14 May) with mainly Quiet to Unsettled conditions expected by day 3 (15 May) along with a slight chance of Active intervals.

**Energetic Particles / Solar Radiation:** GOES-18 proton flux has recently shown an uptick in response to the M6.6 flare at 13/0944 UTC, and this gives a likelihood of reaching the S1 Minor Radiation Storm level by the end of day 1 or day 2 (13-14 May). Further significant flaring from AR3644 is also likely to direct high energy protons towards Earth, with its west limb location well connected due to the Parker Spiral. High energy electron flux is also forecast to rise as solar winds ease, with any charging that has occurred at lower orbits expanding out to GEO. This brings a likelihood of High electron flux by day 3-4 (14-15 May), along with a chance of Active electron fluence.

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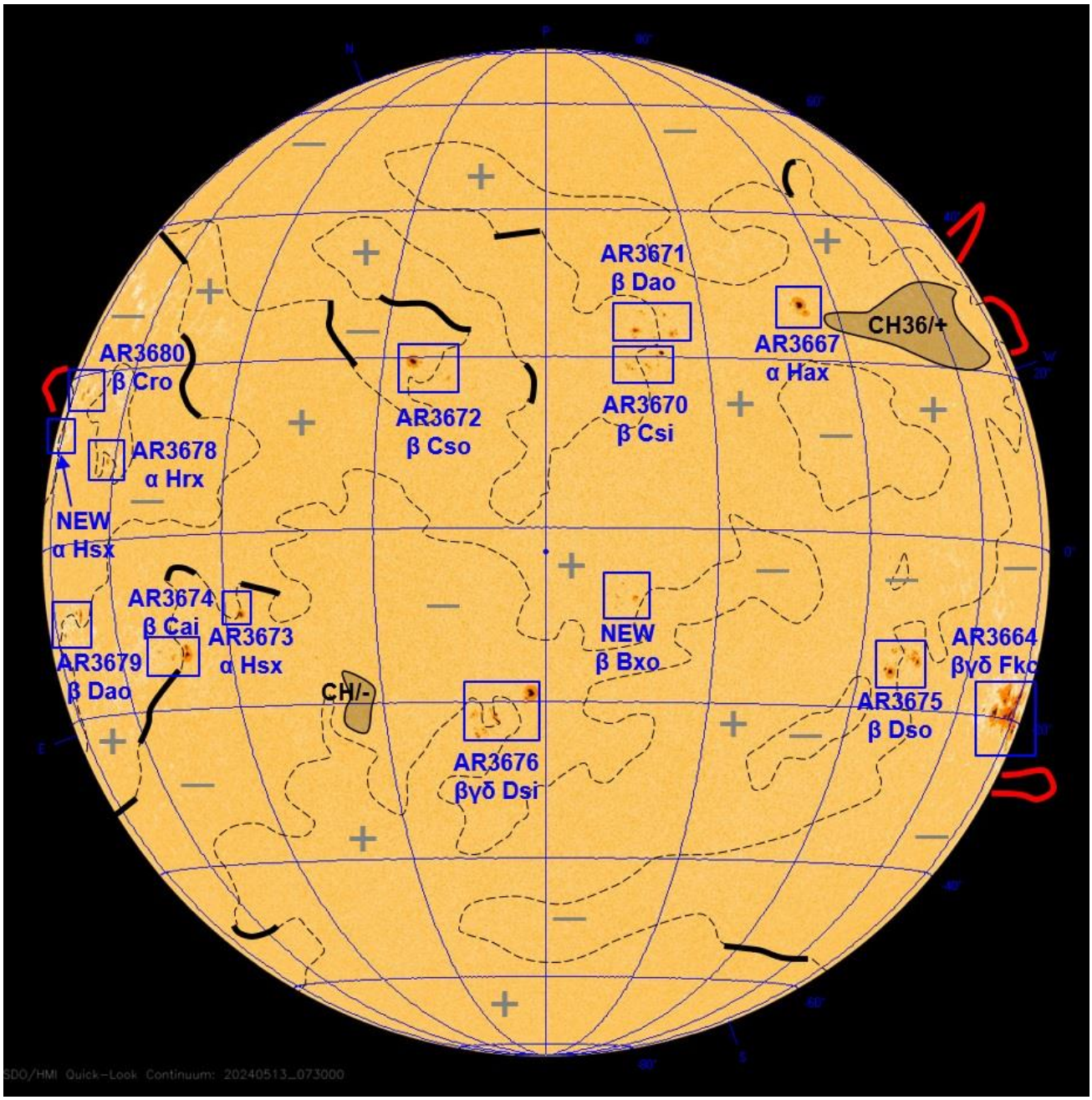
**Figure 1. Solar Analysis Valid 20/0800 UTC.**

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**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

There are no further CME's currently expected to arrive at Earth during the period, however due to the number of CMEs that have been released from AR3664, ongoing glancing influences from those passing ahead of Earth cannot be ruled out on day 1-2 (13-14 May), including the CME from the M8.8 flare on 11 May.

Otherwise the recently enhanced geospace environment is expected to ease towards background conditions, although perhaps initially seeing the decline of wind speeds delayed due to any influence from the HSS of CH36/+, although this is likely to have a negligible effect on the geomagnetic activity.

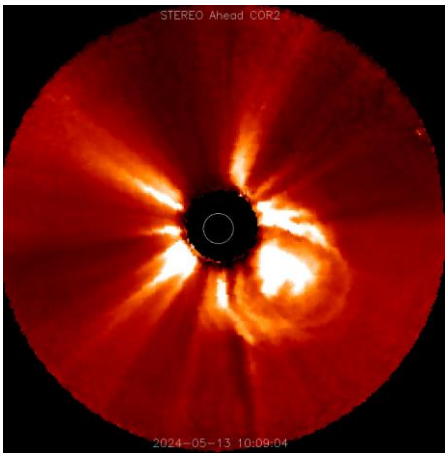
Overall activity is expected to be Unsettled to Active at first, but due to the strength of the solar wind, coupled with any passing CME influence, there is an ongoing likelihood of further G1-G2 Minor-Moderate storms. However this risk declines through day 1-2 (13-14 May) with mainly Quiet to Unsettled conditions expected by day 3 (15 May) with a slight chance of Active intervals.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | Yes | 90 | 25 | 5 | 5 |
| Strong | G3 | No | 10 | 5 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

No further Earth-directed CMEs currently expected.

**Figure 2a: St-A large CME from M6.6 flare.** This has yet to be assessed, but unlikely to have a significant Earth-directed component

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## Radio Blackouts - X-Ray Flares:

Activity is expected to remain High to Moderate days 1-2 (13-14 May), with further M-flares expected, and a likelihood of isolated X-flares.

This is risk is predominately from AR3664, now on the southwest limb. This has remained very large and very active spot, with seven X-class flares and numerous M-flares observed between 08-12 May. While analysis of the region is now difficult due to the spots location, similar flares remain likely, even as this moves onto the far-side during day 2 (14 May). This is supported by the significant looping visible in SDO imagery above the spot which is showing sign of development and instability. An R4-R5 blackout (X10+ flare) cannot be completely ruled out, before the spot and its looping disappears completely over the limb.

There are a total of fourteen sunspot regions on the disc, however aside from AR3664, they are much smaller and simpler providing only a chance of isolated M-flares. Perhaps the main exception is AR3664 in the south-centre disc, which has developed a small delta configuration. There is also a general slow growth trend on a number of the spots.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | Yes | 95 | 90 | 60 | 40 |
| Very Active | R3 to R5 X Class | Yes | 70 | 70 | 25 | 5 |

**Figure 3: GOES-16/18 X-ray Flux**

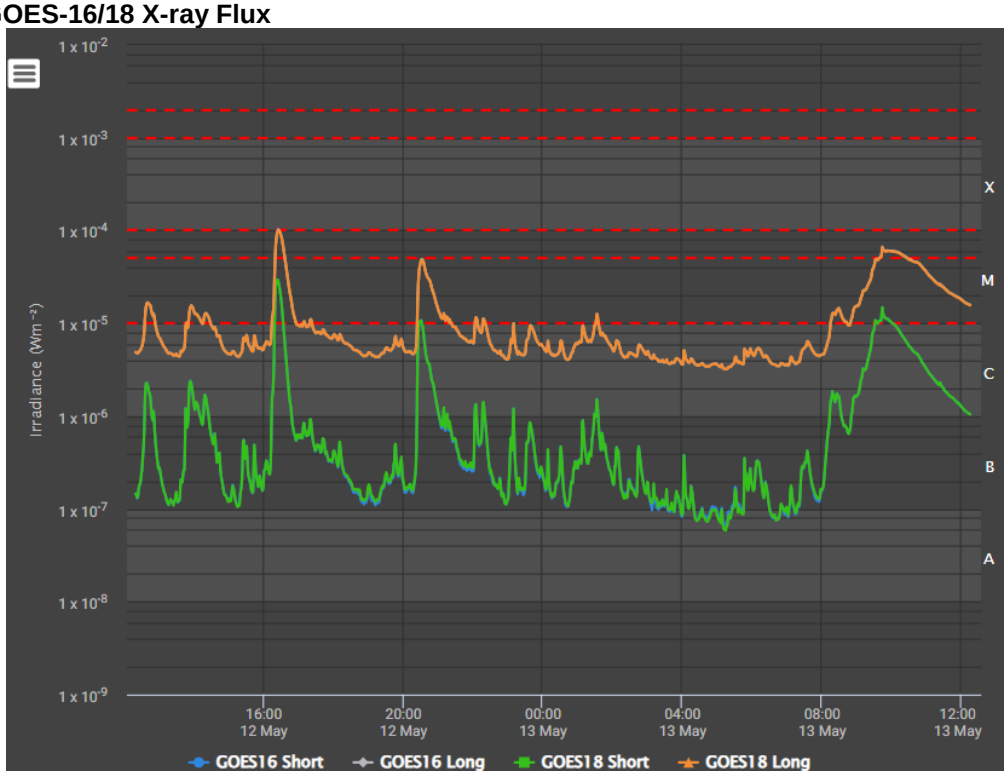


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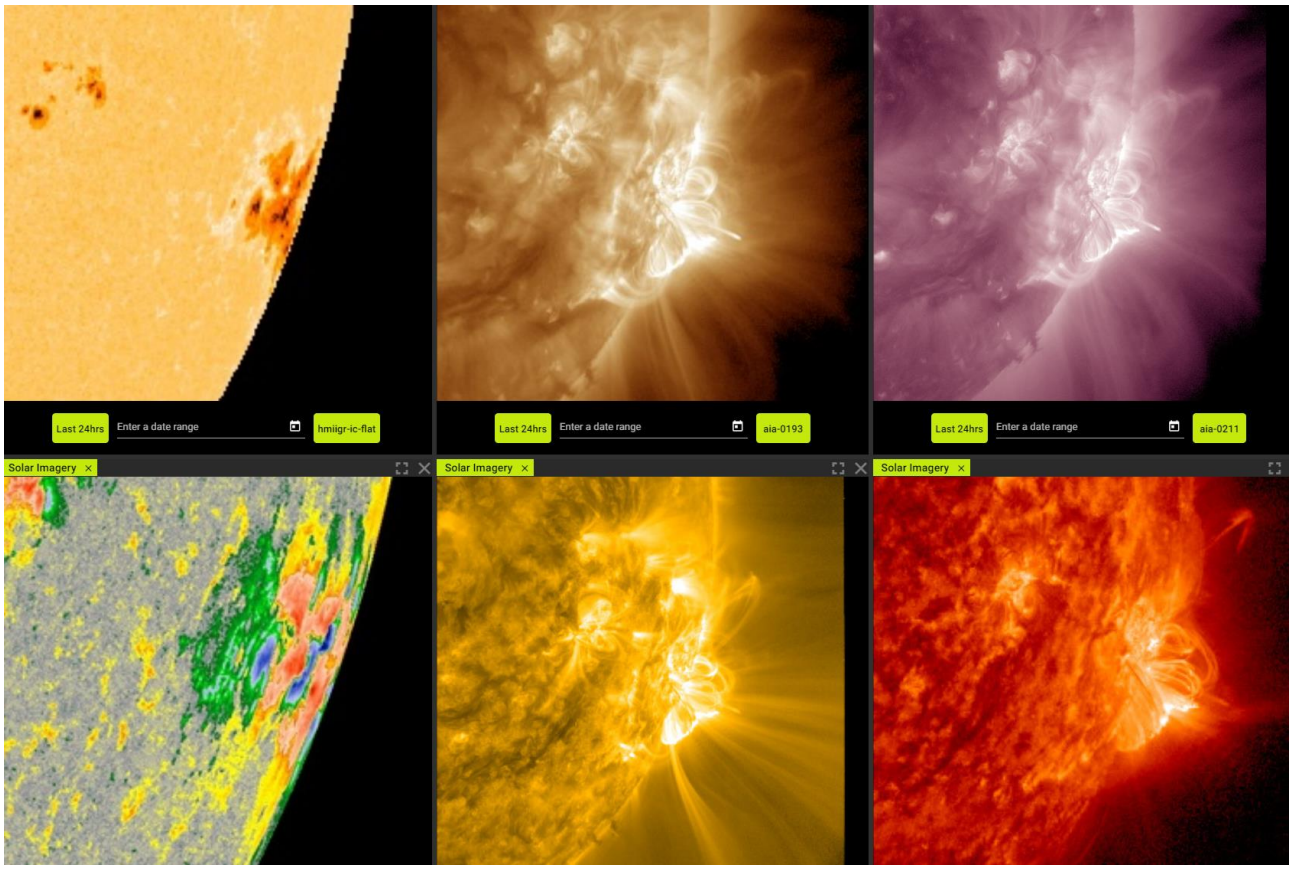
**Figure 3b: SDO imagery of SW limb post M6.6 flare (AR3664 on limb, AR3675 also visible)**




## Solar Radiation Storms - (High Energy Protons):

High energy proton flux at GOES-18 persists slightly above background after the recent High solar activity from AR3664, but now below the S1 level.

AR3664 continues to be a large and potent spot, now on the southeast limb, with any subsequent flare activity having the potential to release further high energy protons that follow the Parker Spiral back to Earth. This will continue to bring a chance of further S1-S2 Radiation Storms, with a slight chance of reaching greater than S3 should any further X-flares occur.

Furthermore, the long period M6.6 flare at 13/0944 UTC from AR3664 had an associated Type IV radio burst, which is often associated with proton release, and giving an expectation of the S1 threshold being reached later on day 1 and into day 2 (13-14 May).

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | Yes | 80 | 80 | 50 | 10 |
| **Very Active** | **≥ S3 *** | No | 15 | 15 | 10 | 1 |

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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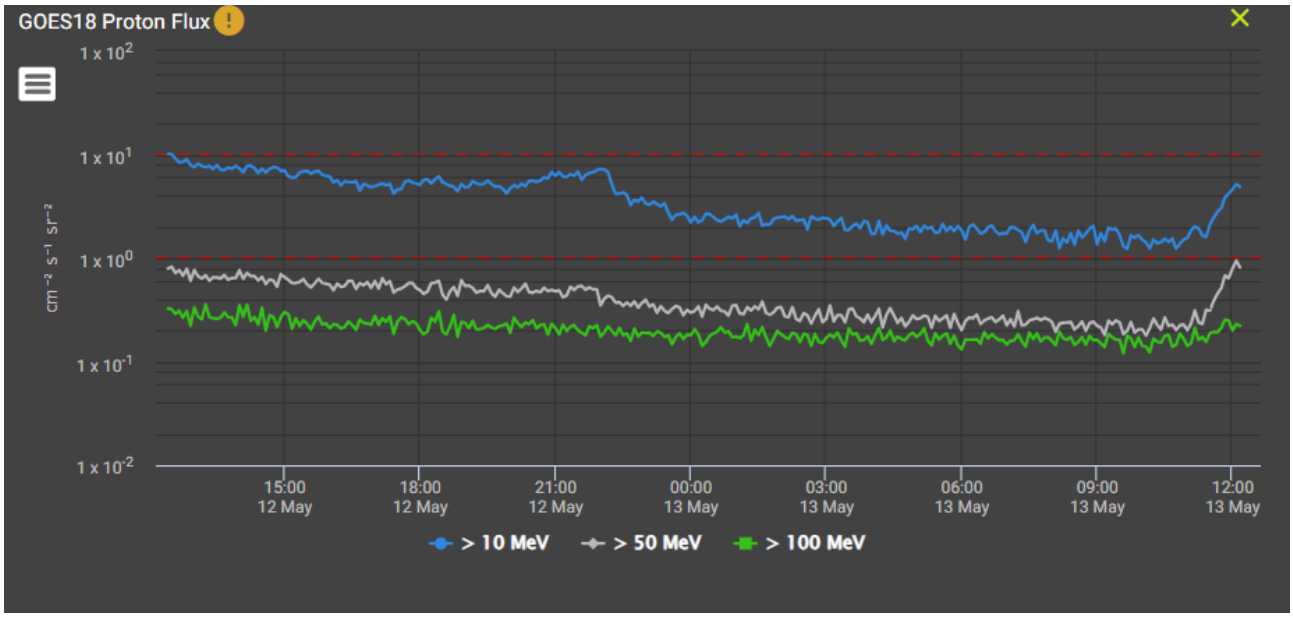
**Figure 4: GOES-18 Proton Flux. Recent uptick visible**




## High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16 is currently Background to briefly Moderate, but is likely to see a significant increase during the period, as solar winds ease. The CME arrivals have likely resulted in a charging at lower orbits, and as the Van Allen belts ease back towards GEO, this charging is expected to bring initially more persistent Moderate flux, but likely persistently High electron flux by day 3 (15 May).

The associated 24 fluence will subsequently respond with a gradual rising trend, with a likelihood of reaching Active by the end of day 3 (15 May). This rising trend is supported by MOSWOC REFM, although the model is currently overestimating forecast values.

| GEO Electron Environment | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ 2 MeV ≥ $1x10^8$ | No | 1 | 30 | 60 | 60 |
| Very Active | ≥ 2 MeV ≥ $1x10^9$ | No | 1 | 1 | 5 | 5 |

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